



# Effect of Organic Manure and Zinc on Growth, Yield Attributes and Economics of Maize

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

A field experiment was conducted during *Rabi* 2022 season at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, to study the response of organic manure and soil application of zinc on the growth, yield attributes and economics of maize. The treatment consists of three level of zinc sulphate (2, 4 and 6 kg/ha) vermicompost (12 t/ha), poultry manure (4 t/ha) and control. The experiment was laid out in Randomized Block Design (RBD) with ten treatment and replicated thrice. The soil of the experimental field was sandy loam with pH (8.0), EC (0.56 ds/m), organic carbon (0.62%), available N (225 kg/ha), available P (38.2 kg/ha), and available K (240.7 kg/ha). The results showed that application of 50% poultry manure and 50% vermicompost along with zinc 6kg/ha recorded significantly higher plant height (208.33 cm), higher dry weight (89.90 g), number of cobs/plants (2.93), cob length (29.80 cm), number of seeds/cob (414.70). Maximum gross returns (254310.40 INR/ha), net returns (173950.40 INR/ha) and Benefit Cost (B.C) ratio (2.16).

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## 1. INTRODUCTION

*Zea mays* L., also known as maize, is regarded as one of the most significant cereal crops in the world due to its wide range of uses as food, feed, and fodder. On the basis of the endosperm of the kernels, maize is divided into many categories or varieties, including dent corn, popcorn, waxy corn, flint corn, pod corn, and sweet corn, among others. Dent corn (*Zea mays* indenata), also referred to as "grain corn," is the most typical variety of maize farmed on a big scale for commercial purposes. With a total production 1018 million tonnes at an average productivity of 5.49 tons per hectare, maize is grown on 185 million hectares of land in 160 countries. The USA produces around 35% of the world's maize, making it the top producer in the world.

Poultry manure is a readily available fertilizer that works well as a substitute for chemical-based fertilizers [17-8]. Exchangeable cations increase after manure application, and the amount of nitrogen in the soil rises by nearly 53% (from 0.09 to 0.14%) [9]. In agriculture, using poultry manure is primarily done to provide crops with nutrients and to alter the soil organically [10]. Due to its high levels of N, P, and K as well as other essential nutrients, poultry waste makes an excellent organic fertilizer. In comparison to other organic sources, it is said to provide P that is ready to be planted [11,12]. Therefore, the goal of this study was to ascertain how applying poultry manure at various rates will affect the soil's availability of phosphorus and the growth of the maize plant [13-15].

Vermicompost is a good substitute for commercial fertilizer and has more N, P, and K content than the typical heap manures [16-21]. Vermicompost was significantly influenced the grain yield of maize, starch content in the grain, a thousand kernel weight, and content of the five observed macro-elements. Furthermore, switching to organic farming will lessen the additional environmental damage brought on by the manufacture of these synthetic fertilizers [22,23].

Zinc deficiency in soil is a worldwide nutritional constraint for crop production, especially cereals [24,25] In India, it has been calculated that 36.7% of soils are zinc (Zn) deficient [26-29]. Plant physiologists evaluated and recorded the decrease in maize yield brought on by the

absence of zinc (Zn) application. Basic plant life processes like (a) nitrogen metabolism - nitrogen uptake and protein quality; (b) photosynthesis - chlorophyll synthesis; (c) resistance to abiotic and biotic stresses - protection against oxidative damage are all greatly influenced by zinc [30].

## 2. MATERIALS AND METHODS

This experiment was carried out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25° 39' 42" N latitude, 81° 67' 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design consisting of ten treatments with T<sub>1</sub> - Poultry Manure 4t/Ha + 2 kg/ha Zinc, T<sub>2</sub> - Poultry Manure 4t/Ha + 4 kg/ha Zinc T<sub>3</sub> - Poultry Manure 4t/Ha + 6 kg/ha Zinc, T<sub>4</sub> - Vermicompost 12t/Ha + 2 kg/ha Zinc, T<sub>5</sub> - Vermicompost 12t/Ha + 4 kg/ha Zinc, T<sub>6</sub> - Vermicompost 12t/Ha + 6 kg/ha Zinc, T<sub>7</sub> -50% Poultry Manure + 50% Vermicompost + 2 kg/ha Zinc, T<sub>8</sub> -50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc, T<sub>9</sub> -50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc, T<sub>10</sub> - Control (RDF). The soil of experimental field was sandy loam with pH (8.0), organic carbon (0.62%), available N (225 kg/ha), available P (38.2 kg/ha), and available K (240.7 kg/ha). The crop was sown on 17<sup>th</sup> December 2022 with seed rate of 10kg/ha. Seeds are sown at a spacing of 30 cm × 15 cm. Data recorded on different aspects of crop, viz., growth parameters and yield attributes were subjected to statistically analysis by analysis of variance method [31] and economic data analysis by mathematical method.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Parameters

#### 3.1.1 Plant height (cm)

The data revealed that significantly higher plant height (208.33 cm) was recorded in treatment 9 [50% Poultry Manure + 50% Vermicompost + Zinc 6 kg/ha] followed by treatment 8 with application of 50% Poultry Manure + 50% Vermicompost + Zinc 4 kg/ha (202.67 cm).

The plant height of maize was found increasing significantly during all crop growth stages, this

could be attributed to the fact that integrated use of organic manure and foliar application of micronutrient zinc led to adequate and balanced nutrient supply to the crop at right time and right place, this promoted rapid vegetative growth, resulting in production of more number of internodes and leaves, thus enhancing the plant height [32-35]. The results are in close accordance with findings of Naga Vani et al. [36].

### 3.1.2 Plant Dry Weight (g/plant)

Significantly maximum plant dry weight (89.90 g) was recorded in treatment 9 [50% Poultry Manure + 50% Vermicompost + Zinc 6 kg/ha]. Whereas, treatment 8 [50% Poultry Manure + 50% Vermicompost + Zinc 4 kg/ha] (84.01 g) and treatment 7 [50% Poultry Manure + 50% Vermicompost + Zinc 2 kg/ha] (83.96 g) were found to be statistically at par with treatment 9.

The application of plant nutrient in combination of organic and inorganic enabled the availability of plant nutrients throughout the growing season, increased the plant height, number of leaves/plant and total leaf area and eventually increasing the plant dry matter production. The improvement in number of leaves might have increased the photosynthetic efficiency of maize and have induced to produce more plant dry matter. This was in accordance with the earlier findings of Kalaraju et al. (2011) and Rajesh [37].

## 3.2 Yield Attributes

### 3.2.1 Number of cobs/plant

The data revealed that maximum number of cobs per plant (2.93) was recorded in treatment 9 [50% Poultry Manure + 50% Vermicompost + Zinc 6 kg/ha] which was superior over all other treatments, followed by treatment 8 (2.74) with the application of [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc].

Nagavani et al. [36] confirmed these results with the application of nutrient sources in organic and inorganic combination along with foliar application of zinc ultimately accrued huge quantity of biomass and partitioned a large fraction of assimilates to the sink, resulting in enhanced yield structures (cobs) as displayed by all the yield attributes.

### 3.2.2 Cob length (cm)

In treatment 9 [50% Poultry Manure + 50% Vermicompost + Zinc 6 kg/ha] was recorded

maximum cob length (29.80 cm) which was superior over all other treatments. However, the treatment 8 [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc] (28.19 cm) was found to be statistically at par with the treatment 9.

Prajapati et al. [38] revealed that application of 100% NPK and vermicompost recorded significantly higher growth components like increasing plant height per plant (158.22 cm), number of leaves per plant (11.00), leaf length per plant (46.87 cm), cob length (17.50 cm), test weight (209.26 g) and dry weight per plant (163.46 g) in maize.

### 3.2.3 Number of seeds/cob

Treatment 9 [50% Poultry Manure + 50% Vermicompost + 6 kg/ha], was recorded significantly maximum number of seeds/cob (410.70) which was superior over all other treatments. However, the treatment 7 [50% Poultry Manure + 50% Vermicompost + 2 kg/ha Zinc] (378.49) and treatment 8 [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc] (397.11) was found to be statistically at par with the treatment 9.

The conjunctive application of inorganics and organics fertilizers has probably increased uptake of nutrients that led to better translocation of photosynthates. Hence enhancing the yield attributes. These findings are in close accordance of Aparna et al. [39].

## 3.3 Economics

### 3.3.1 Maximum Gross Returns (INR/ha)

Treatment 9 with the application of [50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc] was recorded higher gross returns (254310.40 INR/ha) than other treatment which was closely followed by treatment 8 with the application of [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc] (250007.40 INR/ha).

### 3.3.2 Net returns (INR/ha)

Treatment 9 with the application of [50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc] recorded higher net return (173950.40 INR/ha) as against other treatment which was closely followed by treatment 8 with the application of [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc] (169767.40 INR/ha).

**Table 1. Effect of Organic Manure and Zinc on Growth Parameters of Maize**

S. No.	Treatment combinations	At 100 DAS	
		Plant height (cm)	Dry weight (g/plant)
1.	Poultry Manure 4t/ha + 2 kg/ha Zinc	196.67	81.64
2.	Poultry Manure 4t/ha + 4 kg/ha Zinc	192.97	80.61
3.	Poultry Manure 4t/ha + 6 kg/ha Zinc	194.67	79.73
4.	Vermicompost 12t/ha + 2 kg/ha Zinc	197.99	81.22
5.	Vermicompost 12t/ha + 4 kg/ha Zinc	188.82	75.20
6.	Vermicompost 12t/ha + 6 kg/ha Zinc	196.33	79.59
7.	50% Poultry Manure + 50% Vermicompost + 2 kg/ha Zinc	191.33	83.96
8.	50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc	202.67	84.01
9.	50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc	208.33	89.90
10.	Control (RDF)	185.91	76.85
	F-test	S	S
	SEm(±)	4.13	2.37
	CD (p=0.05)	12.28	7.04

**Table 2. Effect of Organic Manure and Zinc on Yield attributes of Maize**

S. No.	Treatment combination	No. of cobs/plants	No. of seeds/cob	Cob length (cm)
1.	Poultry Manure 4t/ha + 2 kg/ha Zinc	2.47	336.47	20.23
2.	Poultry Manure 4t/ha + 4 kg/ha Zinc	2.13	328.58	18.65
3.	Poultry Manure 4t/ha + 6 kg/ha Zinc	1.97	342.49	19.29
4.	Vermicompost 12t/ha + 2 kg/ha Zinc	2.21	337.57	22.05
5.	Vermicompost 12t/ha + 4 kg/ha Zinc	2.62	360.54	25.03
6.	Vermicompost 12t/ha + 6 kg/ha Zinc	1.73	371.57	24.18
7.	50 % Poultry Manure + 50% Vermicompost + 2 kg/ha Zinc	2.57	378.49	23.74
8.	50 % Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc	2.74	397.11	28.19
9.	50 % Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc	2.93	414.70	29.80
10.	Control (RDF)	1.61	310.53	16.94
	F-test	S	S	S
	SEm(±)	0.28	12.97	1.42
	CD (p=0.05)	0.83	36.77	4.23

**Table 3. Effect of Organic Manure and Zinc on Economics of Maize Production**

Sr. No.	Treatment combinations	Gross return (INR/ha)	Net return (INR/ha)	B:C Ratio
1	Poultry Manure 4t/ha + 2 kg/ha Zinc	174929.20	114809.20	1.91
2	Poultry Manure 4t/ha + 4 kg/ha Zinc	180907.13	120667.13	2.00
3	Poultry Manure 4t/ha + 6 kg/ha Zinc	186261.60	125901.60	2.09
4	Vermicompost 12t/ha + 2 kg/ha Zinc	218623.60	118503.60	1.18
5	Vermicompost 12t/ha + 4 kg/ha Zinc	219604.47	119364.47	1.19
6	Vermicompost 12t/ha + 6 kg/ha Zinc	234475.84	134115.84	1.34
7	50% Poultry Manure + 50% Vermicompost + 2 kg/ha Zinc	194992.03	114872.03	1.43
8	50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc	250007.40	169767.40	2.12
9	50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc	254310.40	173950.40	2.16
10	Control (RDF)	125200.80	84575.80	2.08

MSP for Maize – 1962 INR/q

### 3.3.3 Benefit cost ratio

Treatment 9 with the application of [50% Poultry Manure + 50% Vermicompost + 6 kg/ha Zinc] was recorded higher B:C ratio (2.16) than other treatments which was closely followed by treatment 8 with application of [50% Poultry Manure + 50% Vermicompost + 4 kg/ha Zinc (2.12).

## 4. CONCLUSION

Based on the finding it is concluded that with the application of 50% Poultry Manure and 50% Vermicompost along with 6 kg/ha Zinc has responded with better growth parameters, yield attributes as well as Benefit Cost (B:C) ratio.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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